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GOVERNING BLUE NATURE: RETHINKING MARINE CONSERVATION LAW THROUGH THE LENS OF OCEAN CARBON, BIODIVERSITY, AND GOVERNANCE GAPS

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Abstract

Marine conservation law is finding itself in a turning point as the world struggles to achieve the 30 × 30 goals of biodiversity and faces increasing oceans challenges. Although there are legal obligations applicable such as UNCLOS, CBD, and BBNJ Agreement, its effectiveness in marine conservation activities or marine protected areas (MPAs) has not been successful in regard to ecological outcomes. This paper examines the disconnect between the law and ecological health with special emphasis on the lack of coordination between ocean carbon sequestration, climate resilience and biodiversity protection. This study has examined peer-reviewed publications since the year 2020 and given the importance of the lapses in governance. These comprise of legal control of mesopelagic carbon sinks, low application of ecosystem management and inability to integrate functions of blue carbon in Marine Protected Area (MPA) planning. There is still a lack in integrated mechanisms of international legal systems, and their approaches to biodiversity and climate include siloed approaches and are inconsiderate of the interconnectedness of the ocean ecosystem. Also, forms of governance that are driven by communities, indigenous people and non-governmental organizations are often out of the formal legal framework, which diminishes the ability of these models to be adaptive and justice-oriented in conservation. The article supports the idea of a single, legally integrated and carbon conscious marine conservation strategy and a focus on adaptive, enforceable and inclusive legal frameworks. It recommends the balancing of treaties, creation of area-targeted legislation instruments, which consider the functions of carbon, and reconsidering marine preservation regulations to place strong emphasis on both ecological quality and social equity.

1. INTRODUCTION:

The ocean plays an important role in stabilizing the climate of the earth, biodiversity and sustaining the coastal communities. Nevertheless, the growing risks of climate change, loss of biodiversity, pollution and other pressures on the marine environments, attach threatening effects to the marine ecosystems [1, 2]. The international community of law-makers in this field has responded to these calls by significant

commitments to preserve marine biodiversity, including international commitments to the aim of declaring 30 per cent. of the land and sea as, conserved zones by 2030 in the Kunming-Montreal Global Biodiversity Framework. The core of such endeavors is the notion of marine protected areas (MPAs) that are commonly described as the legal framework of the marine conservation. There is however increasing evidence to suggest that most MPAs are paper parks existent legally, but practically useless because of lack of enforcement, fragmented jurisdiction, and inappropriateness with ecological realities [3, 4].

Laws that include the United Nations Convention on the Law of the Sea (UNCLOS), the Convention on Bio-Diversity (CBD) and the recently adopted Agreement on Biodiversity Beyond National Jurisdiction (BBNJ) have provided mere overlapping mandates to marine conservation. Although all of them have useful legal instruments, like area-based management, environmental impact analysis, conservation requirements, their separation has made these instruments less successful at tackling the potential risks which occur in pairs, including climate change and biodiversity loss [5, 6]. One of key gaps is that the legal processes have not successfully implemented marine carbon sequestration commonly known as blue carbon in MPA systems, yet the ocean is playing a crucial role in sequestering over 25% of man-made CO2 [7, 8].

This article provides a legal and ecological critique of the idea of the international marine conservation, summarizing the knowledge of 35 peer-reviewed publications that are conducted between 2020 and 2024. It explores the ecological success of MPAs, how ocean carbon sinks are legally dealt with and what the gaps in governance prevent; inclusive and enforceable ocean protection. This analysis concludes that a paradigm shift is necessary in favor of integrated and adaptive frameworks of marine legal systems that consider ecological functioning and are congruent with legal structures.

2. Legal Architecture to Marine conservation:

International marine conservation law lies in an intricate network of juridical tools that have undergone decades of development, but are still only partially in accordance with the modern ecological facts. The central one is the United Nations Convention on the Law of the Sea that outlines the jurisdiction of the coastal states and has express duties to conserve and preserve the marine environment (Art. 192) and avoid pollution (Art. 194). Although UNCLOS provides some fundamental principles in the form of marine environmental protection, it was not intended to deal with such modern issues as the loss of biodiversity or ecosystem changes driven by climate changes [9, 10].

The Convention on Biological Diversity (CBD), which was adopted in 1992, is a complement to UNCLOS as it promotes the in-situ conservation with the help of protected areas, as well as sustainable use and fair distribution of benefits. The Kunming-Montreal Global Biodiversity Framework (2022) increased the goals greatly, by urging that 30 percent of the ocean should be legally declared ecologically representative and well-managed areas by 2030[2]. The CBD, however, has no real enforcement motives and rather requires national implementation, which has led to significant differences in coverage, strictness of the law, and ecological consequences [11].

One of the significant advances in the international marine law is the Agreement on Biodiversity Beyond National Jurisdiction of 2023 (BBNJ). The recently named high seas treaty attempts to deal with the issue of biodiversity protection in the regions outside of national jurisdiction (ABNJ) representing almost half of the terrestrial surface [12]. The BBNJ Agreement establishes a legal instrument like the regulation of marine genetic resources, area-based management tools (ABMTs), capacity building, and obligatory environmental impact assessment (EIA) in the waters [13]. The treaty has several potentials but its implementation will require harmonization with the UNCLOS and cooperation of the parties of the treaty, particularly in the presence of the power asymmetries in ocean governance [14].

The other instruments, like United Nations Framework Convention on Climate change (UNFCCC), the International Convention on the Regulation of Whaling (ICRW) and the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), provide sector-specific provisions. Although, they are fragmented and in policy silos. This has been worsened by the inadequate coordination across the treaties such that the combinatorial efforts of treating overlapping problems such as loss of biodiversity-rich, carbon-sequestering ecosystems such as seagrasses, mangroves and mesopelagic fish habitats are unable to be achieved [15, 16].

Overall, marine conservation has an inconsistent and inconsiderate legal structure as mandates and tools are mixed up in federal, state, and local levels. Though, the international law has come a long way in instituting marine environmental norms, it has been falling behind in incorporating ecosystem-based management, climate resistance and carbon sequestration in the enforceable conservation plans. Not only do these gaps undermine the effectiveness of the law but also the world response to the soaring ecological crises in the ocean.

3. Marine Protected Areas: Legality, Ecological Realities:

Marine Protected Areas (MPAs) have assumed a critical role in the conservation strategy of the international community and now are most commonly employed to protect biodiversity, to control resource consumption as well as to preserve the ecosystems. The coverage of MPA in the world has now taken immense proportions as it is close to 8 percent of the ocean surface [17]. However, even with legal extension, MPAs still perform poorly in terms of their ecological performance, as a result of a complex of inadequate legal design, lack of enforcement and failure to include effective ecological functioning like carbon cycling [18, 19].

MPAs have legal basis in international competencies like the CBD that under Article 8 advocates that states should set up areas of conservation to advance biodiversity and UNCLOS that authorizes states to implement conservation measures within their Exclusive Economic Zones (EEZs) [20]. The biodiversity requirements of the recent Kunming-Montreal Global Biodiversity Framework have solidified these requirements with Target 3 which aims to have 30 percent of marine and coastal ecosystems effectively conserved using ecologically representative and well-linked systems of MPAs by 2030 [21]. Nevertheless, what is meant by the effective conservation is still disputed and there is a wide range in the application over jurisdictions.

The truth of the matter is that, there are numerous MPAs known as paper parks just as they are named, but have no capacity to be managed, monitored or enforced [22]. The 2021 review by Sala et al. concluded that less than a third of MPAs around the world have any enforcement active, and only a small percentage of them are up to the standards of being highly protective or fulfill ecological functionality [23]. Besides, names and titles tend to be more concerned with symbolic coverage, rather than ecological performance, thus the inundation of MPAs into low use, low conflict regions in favor of ecologically significant areas at risk due to industrial development.

To this end conservation scientists and legal scholars have championed the use of frameworks of classification of MPAs like the MPA Guide which classifies MPAs not merely by the legal designation but rather by the real conservation performance, governance competency [24]. These frameworks would help close the intention-ecological action disjuncture by appreciating the fact that zoning, no-take status, participatory governance, are all vital attributes of effective protection.

An important point is that blue carbon functions are not taken into consideration in the design of MPA. Although oceanic sequestration of carbon by biological mechanisms including vertical migration of mesopelagic fish, phytoplankton productivity and burial of carbon in ocean sediments (through these mechanisms) is a crucial factor, such processes are seldom considered to designate or evaluate MPA in legal criteria [25, 26]. One example is that based on the type of activity, such as bottom trawling, which has the capacity to resuspend stored carbon, such activities are still

carried out within legal jurisdictions of MPAs in certain regions, compromising biodiversity and climate mitigation outcomes [27].

So, even though the marine conservation law would not be possible without the MPAs, they are still limited in their efficacy by law ambiguity, the simplification of the ecological context, and a situation of institutional fragmentation. MPAs need to be transformed in order to meet their desired purpose by being turned into outcome-based conservation tools and climate resilience, carbon sequestration, and social equity.

4. Ocean Carbon Sequestration: The Missing Legal Link:

The ocean is the planet's largest carbon sink, having absorbed over 25% of anthropogenic carbon dioxide emissions since the mid-1990s [28, 29]. Yet this vital climate regulation function remains largely invisible in the legal architecture of marine conservation. While the role of coastal blue carbon ecosystems such as mangroves, seagrasses, and saltmarshes has gained limited recognition in national climate strategies, broader oceanic carbon processes are still excluded from conservation and fisheries law, including within most Marine Protected Area (MPA) regimes[5, 30].

Ocean carbon sequestration is driven by biological processes collectively referred to as the biological carbon pump. These include carbon fixation by phytoplankton, vertical migration of zooplankton and mesopelagic fish, and carbon burial through sedimentation of organic matter[31, 32]. For example, mesopelagic fish are estimated to transport between 1,800 and 16,000 MtC yr^{-1} through their diel vertical migrations[5], while large predatory fish and whale carcasses contribute further to carbon export to the deep ocean[25]. These processes, if disrupted, can release stored carbon back into the water column or atmosphere, compounding climate change.

International and national marine law regimes do not however operate in a manner that is reflective of this ecological reality. Such fisheries management strategies as Maximum Sustainable Yield (MSY) do not consider any element of species in carbon cycling and only concentrate on population dynamics and economic yield [33, 34]. Similarly, the planning and zoning of MPAs do not pay enough attention to locations with a rich potential of carbon export and other activities, such as bottom trawling and biomass harvesting are conducted in areas that are ecologically sensitive [4, 35].

The 2022 study by Elsler et al., the analysis of more than 2,700 international policy documents under ten major marine agreements such as UNCLOS, CBD, UNFCCC and draft BBNJ Agreement utilized text-mining showing that merely 6% included a mention of ocean carbon (a systemic legal omission). In cases where ocean carbon was being referred to, there were disjointed references and were often not connected to legally binding instruments like environmental impact assessment or area-based banner instruments [5]. This loophole in the law constrains the potential use of the conservation law to advance the goals of climate mitigation as well as to conserve ecosystem functions that are essential in storing carbon.

Other scholars have suggested adding ocean carbon indicators to MPA planning requirements and applying the biological carbon functions as an introduction of a new legal use of conservation zoning [36]. Some propose leveraging the environment-related impact assessment stipulations and area-based instruments in the BBNJ Agreement in order to institute carbon-oriented safeguards in the high seas [37]. Such efforts can however be marginal without concerted legal recognition by treaties that touch on the biodiversity and climate.

In short, ocean carbon sequestration is an element that lacks in marine conservation law. Loss of biodiversity would be safeguarded without understanding its role in the climate, which restricts the climate applicability of law. The incorporation of ocean carbon as a legal matter in MPAs, fisheries legislation, and alignment with treaties is a vital step to tie in biodiversity safeguarding and worldwide climate perspectives.

5. Climate Change, Biodiversity, and Legal Misalignment:

The interdependence between climate change and loss of biodiversity is becoming increasingly understood as a crisis but these elements are

seldom addressed as such within international law on the seas. The increase of ocean temperatures, acidification, and deoxygenation already changes the distribution of species, alters the functioning of the ecosystem and decreases the productivity of the ocean [38-40]. Nevertheless, in spite of these changes, legal frameworks still compartmentalize conservation and climate action that undermines the resiliency that Marine Protected Areas (MPAs) and other conservation instruments possess in responding to a changing ocean environment [5, 40].

Most of the MPAs were set on the basis of an ecological baselining and fail to recognize changes in species distributions, habitat migration, or an ecosystem break even experienced due to climate change [41] (Levin et al., 2020). Consequently, habitats that had initially been biodiversity-rich might eventually end up being ecologically unfavorable whereas novel significant ones are not sheltered to the strict lines of the law. This reduces the ability of the conservation law to adapt to the fast changing of the oceans due to the absence of adaptive legal mechanisms [42, 43]. Furthermore, there were never enforceable biodiversity or climate requirements of the governance of ABNJ (areas beyond national jurisdiction), which harbor a range of ecosystems vulnerable to climate change, a gap that the BBNJ Agreement aims to bridge but is yet to realize [44].

UNCLOS, the CBD, and the UNFCCC are among legal instruments that provide various mandate to marine climate impacts, yet little is done to coordinate them. An example is UNCLOS which compels states to conserve the marine environment (Art. 192) but not to incorporate climate science into conservation practices [45]. The CBD, likewise, promotes the management at the ecosystem level but does not provide binding mechanisms to implement climate sensitive conservation and instead provides discretion on this to the country level. In its turn, the UNFCCC is concerned with emission reduction and adaptation but fail to regulate the ocean ecosystems as carbon storage mechanisms or biodiversity resources [46].

These misalignments in the law are demonstrated with case studies. In the Chagos Archipelago, the UK had made a unilateral declaration of an MPA which was declared illegal by the Mauritius because it did not have consent, and there was no climate or carbon role included in its development [47, 48]. The more vibrant model that has been shown in Raja Ampat in Indonesia though, is community co-management and ecological monitoring leading to adaptive management of reefs and fisheries, albeit inconsistently supported by national legal frameworks [49]. Even the so-called flagship sites such as the Great Barrier Reef are having problems adopting climate risk into the legal governance, yet it is one of the most researched MPAs of the world [50].

Recent sources propose the incorporation of climate resiliency indicators into conservation planning including thermal refugia and connectivity corridors and carbon export areas to future-proof MPAs [50, 51]. But not many legal systems exist which require such a high degree of integration. The majority of MPAs continue to be based on old-fashioned ideas of ecological stability, without take note of the non-linear, threshold-driven interactions of climate-impacted marine systems.

Finally, a breakeven occurs between climate science and conservation law that lacks the provision of long-term uninterrupted biodiversity and climate advantages by MPAs. To close this gap, new ecological standards are necessary, together with legal processes to support adaptive management and inter-treaty coordination, and the ongoing re-definition of conservation priorities in response to the shifts in ocean conditions.

6. Governing Gaps and Equity:

As marine conservation has been driven through the legal and scientific aspects, the governance systems in most cases do not consider the complexity and diversity of ocean users. In special, the Marine Protected Areas (MPAs) are often conceived in a top-down legal format that leaves out Indigenous peoples, coastal communities, and non-state actors that are priority players in long-term stewardship [52, 53]. It undermines legitimacy and effectiveness, and provides

loopholes in its implementation and objections to conservation enforcement.

The significance of traditional knowledge and equitable benefit-sharing is well known internationally in various international frameworks, such as the CBD and the BBNJ Agreement, yet tend to be undermined in domestic implementation [54, 55]. Practically, legal pluralism involving the coexistence of many legal systems, e.g. customary and state law, is rarely incorporated in the marine conservation planning [56]. This invalidates the position of community-based forms of governance, which in most instances, have been more adaptive, economical and ecologically sensitive than involvements led by state actors [57].

Raja Ampat, Indonesia, is an example of such a place. The local management of the marine environment (LMMAs) based on the customary law and facilitated by the NGOs have resulted in some tangible benefits in the reef health and biomass of fish [58]. These models are however successful but being out of statutory safeguards frequently restricts their identification and financing. Conversely, when the heavily regulated MPAs are unresponsive towards the local socio-economic realities, they lead to the occurrence of perverse effects such as more illegal fishing and eviction of the small-scale fishers [59].

An unresolved tension is also exhibited by the role of the NGOs in marine governance. Although most conservation NGOs are essential sources of resources, science, and promotion on the international level, there are still doubts concerning their accountability, cultural sensitivity, and dedication to the long-term perspective [60] (Gurney et al., 2021; Gruby et al., 2016). Certain NGO led MPAs, particularly in the developing countries, have been criticized as the Westification imposition of the Western conservation paradigms, which imposes ecologically utopian solutions with little local participation or positive benefits transfer [61].

Also, access to justice is also hampered by most MPA frameworks. In most instances affected populations do not have legal standing to appeal to conservation designation or enforcement decisions in areas where administrative or judicial redress is weak [62]. Lack of grievance systems and community rights in most conservation regimes not only bring about equity issues but also decrease the validity and adherence capabilities of laws.

The global disparities in ocean research, monitoring technology and capacity of marine policies are adding to these loopholes in governance. Small Island Developing States (SIDS) and least developed countries usually have unequal ecological risks and are deficient in the legal, financial and technical resources to enforce and enforce conservation regulations [62]. Although pledges have been made to the capacity-building as part of both the CBD and BBNJ, it has been very slow and piece-meal.

To take a step towards equitable and viable marine conservation, legal frameworks have to extend beyond the formal protection of the frameworks in ensuring that various systems of governance is recognized and institutionalized. These involve codification of the role of Indigenous knowledge, the right of the people to participate in the legal processes, the accountability of the NGOs and the enhanced access to the legal procedures in the environmental governance. New conservation law can only facilitate stewardship of marine biodiversity in the long run that is sustainable and inclusive when these structural inequities are addressed.

7. Toward a Legally Integrated Marine Conservation Strategy:

International marine law fragmentation coupled with ecological complexity and inequity in governance demands a redrawing of the approach of marine conservation strategy by incorporating into the law the elements of biodiversity, climate, and carbon governance. Despite the overlapping calls of the treaties like UNCLOS, the CBD, and the UNFCCC on the threats of the oceans, they are still legally siloed and conceptually unconnected. These divides need to be crossed through legal design based on sectors giving way to an ecosystem-based approach, which is enhanced by adaptive governance and informed by the emerging ecological science [60, 63].

A hopeful possibility is merging the functions of ocean agenda of carbon trapping based on the inclusion of these functions as part of marine law and regulations. 1 The ecological indices that can be utilized in the zoning and performance assessment of the Marine Protected Areas (MPAs) include the blue carbon data based on the carbon export by mesopelagic (MPAs) fish, phytoplankton productivity, and carbon burying in the benthic sediments [64, 65]. These measurements give a scientific justification of prioritization of areas which are not only rich in biodiversity, but also those which have potential to regulate climate. Ocean carbon functions could be enshrined in the legislation of states with the use of MPA and in the rules to be followed when implementing the BBNJ Agreement, in particular, its environmental impact assessment (EIA) aspects.

It is also important that the treaties be harmonized. As a case in point, a comparison between the general UNCLOS environmental commitments (Articles 192 and 194) and the area-based conservation provisions of the CBD and the adaptation commitments of the UNFCCC could develop a harmonized structure of climate smart conservation. This involves technical co-ordination, inter-treaty discussion and institutional requirements that promote integrated reporting and implementation [27]. An analogous integrative strategy has been suggested as a part of the BBNJ Agreement, with the ABMTs, EIAs and capacity-building, capabilities having the potential to ride on the high seas [66].

The MPA Guide is a useful framework to migrate designation to outcome. Its special attention to transparency of MPA goals, quality of its governance, and ecological performance should be entrenched into instruments of binding. Similar multi-criteria schemes can be adapted to a national legal system, which involves a carbon functionality, biodiversity connective, exposure to threats, and equity of governances. Adaptive conservation can be aided by the legal instruments such as dynamic zoning, conditional licensing, and compulsory ecological performance reviews to consider climate and biodiversity objectives.

Enhancing conservation law also needs to point out various legal systems and decentralizing power. The successes of traditional marine tenure systems, Aboriginal co-governance systems, and Indigenous community-controlled areas have demonstrated success on a number of case studies but have not been valued in legal tools. Legally, these systems ought to be recognized as valid governing partners, and are allowed the right to be involved, watch and impose conservation regulations. The concept of legal pluralism can strengthen the system because it can allow the necessary adaptive responses that are based on the local ecological knowledge and cultural legitimacy.

Finally, a strategy that is legally integrated requires a powerful capacity-building, funding, and technological access, especially in the developing states, and Small Island Developing States (SIDS) in which climate vulnerability and biodiversity hot spots tend to overlap. The legal requirements spelled out in global agreements will only be a dream without significant efforts to reinforce them. Overall, marine conservation policy in future should not be an additive approach of piecemeal mandates like spot mandates but rather a comprehensive, legally specific approach that views biodiversity, carbon and community governance as equal parts of ocean resilience.

8. Conclusion:

The law on marine conservation is on a cross-road. Although there have been international treaties over the years and the development of a growing network of Marine Protected Areas (MPAs), the decline of the ocean biodiversity, the impact of climate, and the disturbances of the carbon cycle are growing. This article demonstrates that frameworks such as UNCLOS, the CBD, the UNFCCC, and the BBNJ Agreement offer valuable tools, but are flawed by their ineffectiveness in terms of integrating carbon roles, and still experience gaps in their governance.

Legal-ecological dissonance is most evident in the fact that ocean carbon sequestration is still under-valued in conservation legislation. Biological carbon pump: Species such as mesopelagic fish, phytoplankton and deep-sea ecosystems constitute the oceanic biological carbon pump that is a critical process in climate regulation, but has little acknowledgment in the majority of conservation

policies and MPA planning processes. This oversight undermines biodiversity, as well as climate strategies, and fails to integrate conservation and climate mitigation.

The little incorporation of the local governance, knowledge of the Indigenous, and equitable enforcing is also an issue of concern. The rights, knowledge and stewardship of coastal communities are not commonly considered by the top-down legal systems, particularly in biodiversity-rich regions of the Global South. Devoid of inclusive governance, even the best made legal provisions stand chances of failure or defiance by the populace.

To curb these problems, the marine conservation law should be more of a whole, climate sensitive, and a more socially inclusive law. This means harmonizing treaty objectives both in the biodiversity and climate policy, blue carbon in the legal conservation principles and codifying the community-based governance. It also requires legal mechanisms to be flexible and be adjusted to changing ecological circumstances and promote conservation oriented in the future.

Marine conservation can only become a reality and not a symbolic endeavor when all three, that is, biodiversity protection, climate resilience, and governance fairness, work together. To safeguard ocean health and guarantee a liveable planet, it is important to shift fragmented mandates to a unified, enforceable and equitable legal framework for marine protection.

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